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Non-inductive current probe

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The design has been used for over two years in our laboratory, never showing superleaks on thermal cycling tens of times without disassembly. The only precaution taken is to use a new ring whenever it is necessary to take apart and reassemble the can.

The assistance in this design of J. Massink and H. Weijers is gratefully acknowledged.

[1] M. Kuchnir *et al.*, Rev. Sci. Instrum. **42,** 536 (1970).
[2] J. E. Vesel, Rev. Sci. Instrum. **43,** 1390 (1972).

Noninductive current probe

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The current probe described is a low-cost, shunt resistor for monitoring current pulses in e.g., pulsed lasers. Rise time is <5 nsec, inductance introduced in the circuit <7 nH, and current handling capability $\sim 100\ A^2$ sec.

DESCRIPTION

The resistance element is made from a stainless steel tube of 4.0-mm i.d. Wall thickness is reduced to 0.15 mm by turning. Current is fed into one end of the tube by means of a small brass plug, insuring a uniform current distribution. The other end of the tube is soldered to a brass body serving as current return path. The voltage drop across the stainless steel tube is fed to a BNC connector screwed into the brass body. A 47-Ω carbon resistor prevents re-reflections.

Due to the cylindrical symmetry the magnetic field from the main current will vanish inside the resistance element. The inductive coupling between "current leads" and "voltage leads" is thus eliminated.

Rise time is limited by skin effect in the stainless steel tube. (Note that in this geometry the voltage measured across the tube decreases as the frequency increases.) Since skin depth depends on frequency f as $f^{-1/2}$, marked improvements are possible by further turning or grinding the stainless steel tube.

It should be noted that commercially available thin-walled tubes made from "Monel," for example, should be avoided due to their magnetic properties.

The shunt described was tested as one part of a voltage divider, the other part being a 47-Ω, coaxially mounted, carbon resistor. Amplitude and phase response of the dividing ratio was measured in the frequency range 10–200 MHz, using a vector voltmeter. From the test results the following data were obtained:

Resistance	31 mΩ
Upper frequency limit (3 dB)	76 MHz
Rise time (10%–90%)	4.6 nsec
Group delay	2.0 nsec

A clean roll off without any overshoot was observed. Inductance introduced in the current path can be calculated to be 6.7 nH.

In practice current handling capability is thermally limited. A rough calculation indicates a 10 °C temperature rise of the resistance element resulting from a 100-A^2 sec pulse.

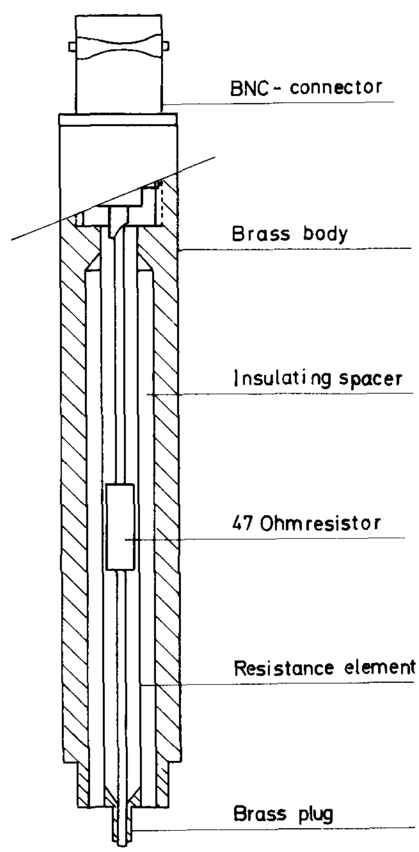

FIG. 1. Current probe, partial sectional view. Active length of the resistance element is 65 mm.